

chapter 2

Indicate whether the statement is true or false.

1. The height of the equatorial tropopause is roughly 18 kilometers.
 - a. True
 - b. False

2. Carbon dioxide is a greenhouse gas.
 - a. True
 - b. False

3. The Air Quality Index ranks air quality by its effects on human health.
 - a. True
 - b. False

4. The environmental lapse rate in the troposphere is 6.5 degrees Celsius per 1,000 meters.
 - a. True
 - b. False

5. The problem with the ozonosphere was known since the 1920s, but wasn't taken seriously until 1974.
 - a. True
 - b. False

6. Nitrogen molecules in the atmosphere are a type of aerosol.
 - a. True
 - b. False

7. The atmosphere is composed of 78% nitrogen and 21% oxygen molecules.
 - a. True
 - b. False

8. Northern lights occur in the mesosphere.
 - a. True
 - b. False

9. On average, the Dead Sea has the highest air pressure on Earth.
 - a. True
 - b. False

10. The tropopause is higher above Earth's surface at the poles than at the equator.
 - a. True
 - b. False

11. CFCs are toxic gases made by people.

chapter 2

- a. True
 - b. False
12. Particulate matter is an aerosol.
- a. True
 - b. False
13. Methane is a greenhouse gas.
- a. True
 - b. False
14. CFCs (chlorofluorocarbons) are gases that occur naturally in the atmosphere.
- a. True
 - b. False
15. In the stratosphere air flows mostly horizontally.
- a. True
 - b. False
16. Nitrous oxide is a greenhouse gas.
- a. True
 - b. False
17. The higher the molecular density of air, the lower the air pressure.
- a. True
 - b. False
18. The Air Quality Index (AQI) scale indicates atmospheric pressure.
- a. True
 - b. False
19. Aurora australis occurs in the Northern Hemisphere.
- a. True
 - b. False
20. China is among the world leaders in cleaning up its polluted air, even though many Chinese cities have some of the world's worst air quality.
- a. True
 - b. False
21. Water vapor can occupy up to 4% of the atmosphere by volume.
- a. True
 - b. False

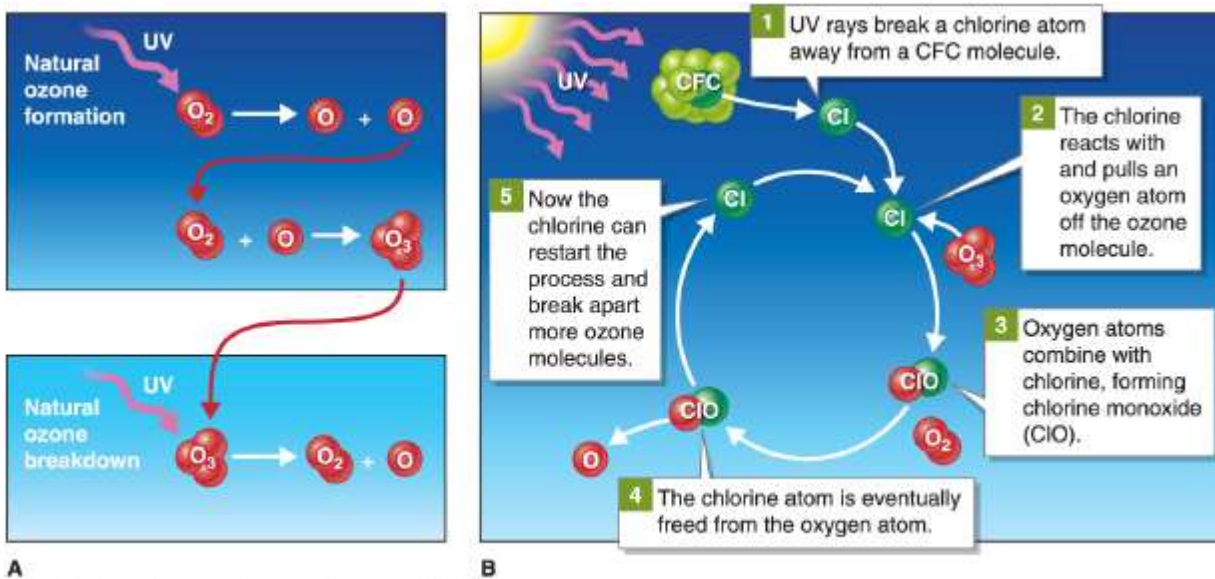
chapter 2

22. PM₁₀ is more unhealthy than PM_{2.5}.
- True
 - False
23. *Tropos* in Greek means to turn over and to mix.
- True
 - False
24. Ground-level ozone is harmless. Stratospheric ozone is harmful to people.
- True
 - False
25. The height of the polar tropopause is roughly 8 kilometers.
- True
 - False
26. Most meteors burn up in the mesosphere.
- True
 - False
27. Ozone molecules form naturally in the stratosphere.
- True
 - False
28. A greenhouse gas absorbs and emits heat.
- True
 - False
29. Most anthropogenic pollutants come from burning fossil fuels.
- True
 - False
30. Oxygen is a greenhouse gas.
- True
 - False
31. Gases enter the atmosphere through gas sinks.
- True
 - False
32. The aurora occur because Earth's magnetic field is protecting us from the solar wind.
- True

chapter 2

- b. False
- 33. Volcanoes make acid rain pollution.
 - a. True
 - b. False
- 34. Northern lights are also called aurora borealis.
 - a. True
 - b. False
- 35. The atmosphere is kept pinned to Earth by gravity.
 - a. True
 - b. False
- 36. Ozone molecules break apart naturally in the stratosphere.
 - a. True
 - b. False

Indicate the answer choice that best completes the statement or answers the question.



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- 37. According to this figure, ultraviolet rays do what?
 - a. form ozone molecules
 - b. break apart ozone molecules
 - c. break apart CFC molecules
 - d. ultraviolet rays do all of the above
- 38. Temperatures in upper reaches of the thermosphere are as high as _____ degrees Celsius.

chapter 2

- a. 100
- b. 550
- c. 1,200
- d. 2,100

39. Clouds are composed of _____.

- a. water vapor
- b. aerosols
- c. nitrogen
- d. CFCs

40. Which statement is not true of the exosphere?

- a. It is the top-most layer of the atmosphere that fades to outer space.
- b. Some gas molecules escape from it out to space.
- c. It is where meteors burn up as they enter the atmosphere from space.
- d. There is almost no air pressure.

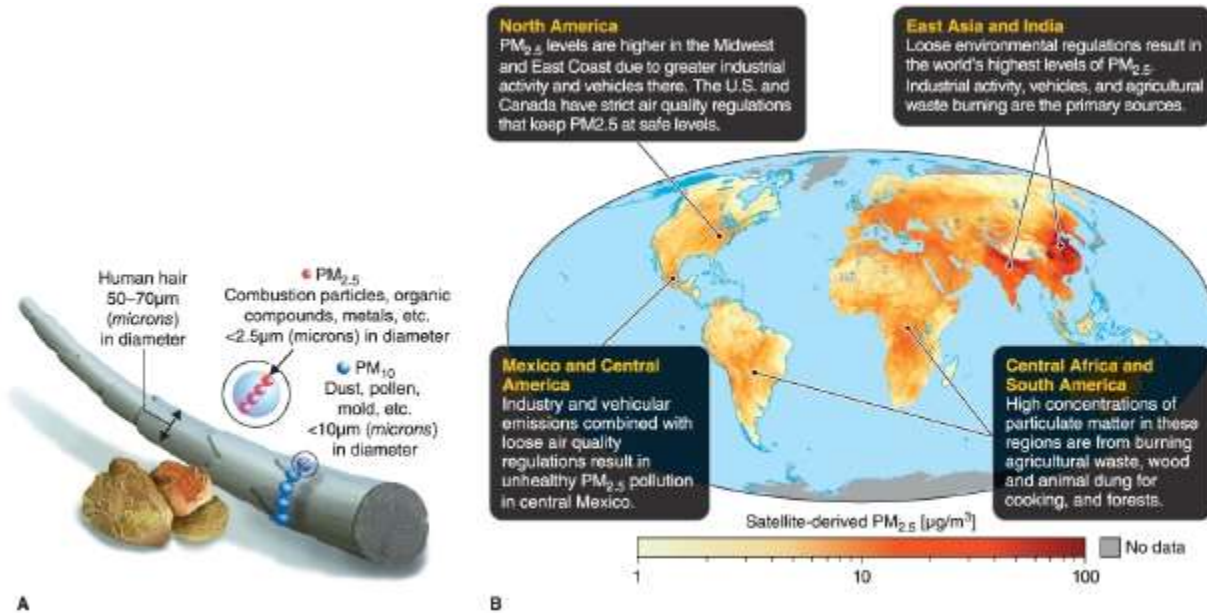
41. The main source of VOCs is _____.

- a. burning of vegetation
- b. burning of coal and gasoline
- c. incomplete burning of gasoline
- d. chemical reactions in sunlight

42. What is a radiosonde?

- a. a scientific instrument attached to a balloon
- b. a type of radar
- c. a scientific instrument attached to an ocean buoy
- d. a scientific instrument attached to a satellite

chapter 2



A. U.S. Environmental Protection Agency; B. Data from van Donkelaar et al. / NASA Earth Observatory

43. Referring to the map, what causes particulate matter to be high in eastern Asia?
- dust storms
 - industrial emissions
 - agricultural emissions
 - photochemical reactions
44. Which is not an example of particulate matter?
- dust
 - smoke
 - ozone
 - pollen
45. The gas that causes ozonosphere thinning is _____.
- methane
 - ozone
 - CFCs
 - carbon dioxide
46. Which is a natural source of carbon dioxide?
- photosynthesis
 - volcanic activity
 - fossil fuel combustion
 - ultraviolet radiation
47. The Clean Air Act was first enacted in _____.

chapter 2

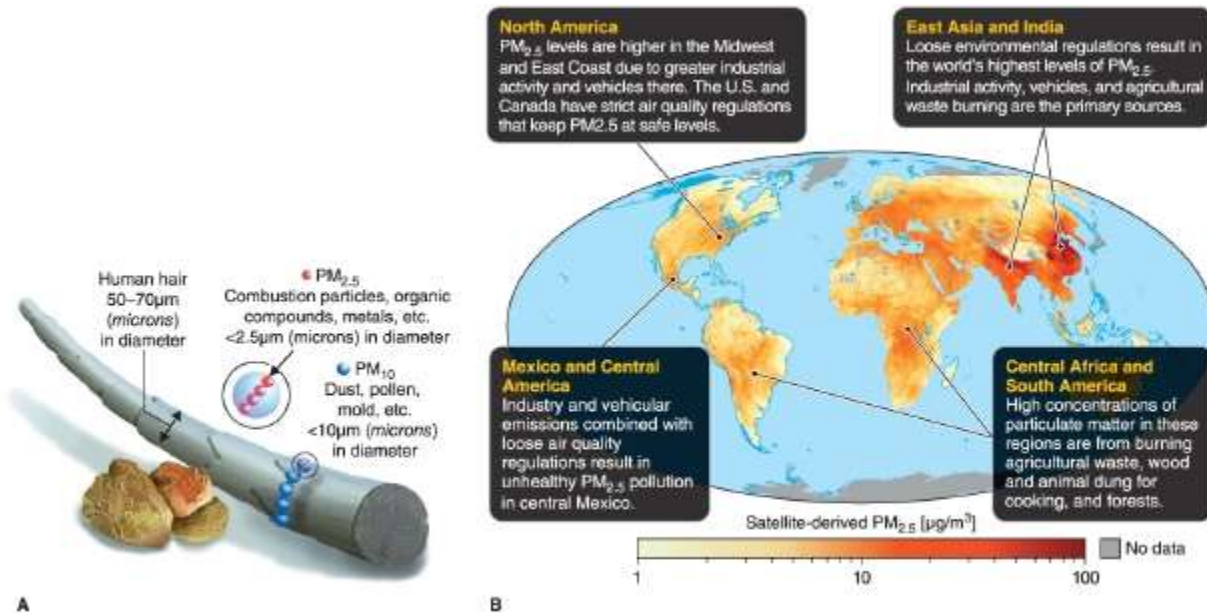
- a. 1963
 - b. 1970
 - c. 1977
 - d. 1990
48. What did the Montreal Protocol mandate?
- a. the phaseout of CFCs
 - b. the phaseout of fossil fuels
 - c. the cleaning up of sulfur dioxide
 - d. the phaseout of ground-level ozone
49. Which is a methane sink?
- a. photosynthesis
 - b. ultraviolet radiation
 - c. the oceans
 - d. rainfall
50. Which is an ozone sink?
- a. photosynthesis
 - b. condensation
 - c. ultraviolet radiation
 - d. fossil fuels
51. Which is not a primary pollutant?
- a. carbon monoxide
 - b. nitrogen dioxide
 - c. ground-level ozone
 - d. sulfur dioxide
52. Which atom comes from a CFC molecule and breaks ozone apart?
- a. fluorine
 - b. chlorine
 - c. carbon
 - d. oxygen
53. Under the Montreal Protocol, CFCs have mostly been replaced by what chemical?
- a. methane
 - b. HFCs
 - c. fluorine
 - d. carbon dioxide

chapter 2

54. Which is a water-vapor sink?
- a. evaporation
 - b. condensation
 - c. ultraviolet radiation
 - d. fossil fuels
55. At sea level there is/are _____ kilogram(s) per square centimeter of air pressure on average.
- a. 1
 - b. 2
 - c. 3
 - d. 4
56. _____ facilitate(s) a reduction of ozone in the ozonosphere.
- a. Particulate matter
 - b. Nacreous clouds
 - c. High atmospheric density
 - d. The presence of nitrogen dioxide
57. Which pollutant causes acid rain?
- a. carbon monoxide
 - b. ground-level ozone
 - c. VOCs
 - d. sulfur dioxide
58. Which molecule does not occur naturally?
- a. ozone
 - b. methane
 - c. carbon dioxide
 - d. CFCs and HFCs
59. Which molecule comes from bacterial decomposition?
- a. ozone
 - b. methane
 - c. carbon dioxide
 - d. CFCs and HFCs
60. The main source of anthropogenic carbon monoxide in urban areas is _____.
- a. automobiles
 - b. coal burning
 - c. burning agricultural wastes and forests
 - d. unburned gasoline

chapter 2

61. A primary pollutant is defined as _____.
- a pollutant that is toxic to humans
 - a pollutant that enters the air or water directly from the source
 - a pollutant that has been altered by reactions with other pollutants
 - a pollutant that is emitted by natural sources such as volcanoes
62. The division between the thermosphere and the exosphere is called the _____.
- tropopause
 - stratopause
 - mesopause
 - thermopause
63. Which of the following is a factor that concentrates air pollution?
- oceans
 - temperature inversions
 - vegetation
 - wind



A. U.S. Environmental Protection Agency; B. Data from van Donkelaar et al. / NASA Earth Observatory

64. Referring to the map, what causes particulate matter to be high in the Sahara in northern Africa?
- dust storms
 - industrial emissions
 - agricultural emissions
 - photochemical reactions
65. The temperature at the top of the mesosphere is about _____ degrees Celsius.

chapter 2

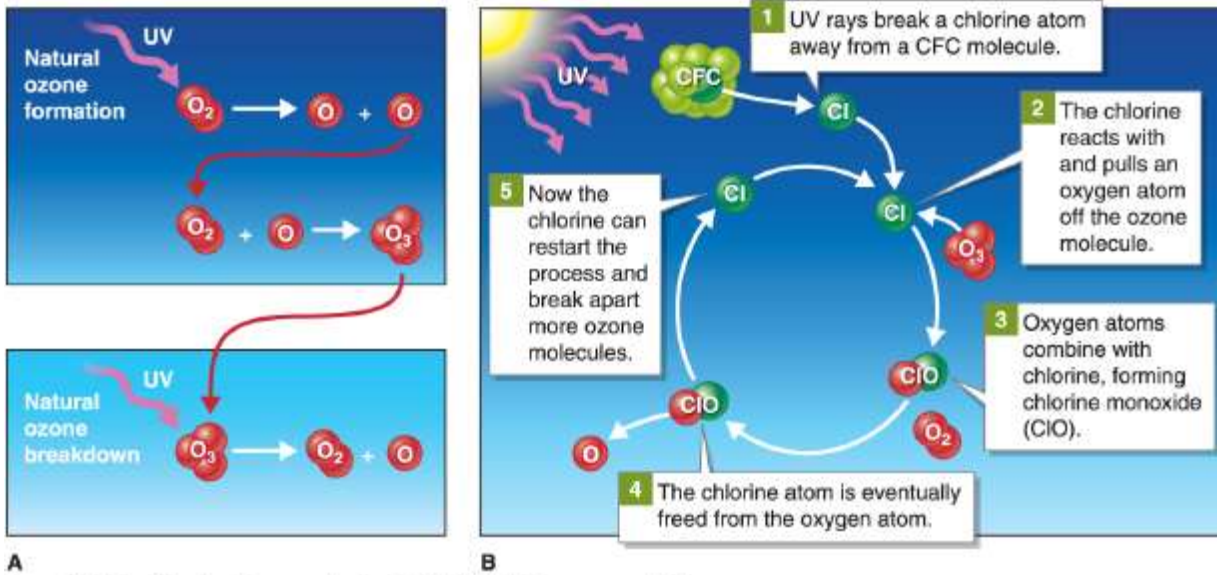
- a. 0
- b. -40
- c. -60
- d. -90

Table 2.4 Anthropogenic Pollutants and Sources

POLLUTANT	MAJOR SOURCES	HEALTH EFFECTS
Carbon monoxide (CO)	Motor vehicles	Headaches, slowed reflexes, drowsiness, death
Nitrogen dioxide (NO ₂)	Motor vehicles, coal burning	Lung irritation, pulmonary disease (e.g., asthma, bronchitis)
Ground-level ozone (O ₃)	Chemical reactions of NO ₂ and VOCs in sunlight	Eye and throat irritation, respiratory disease (e.g., bronchitis and asthma), decreased crop and other plant growth
Sulfur dioxide (SO ₂)	Coal burning, oil refineries	Respiratory symptoms (e.g., wheezing, shortness of breath), acid rain ecosystem damage
Particulate matter (PM)	Coal combustion, industrial processes, motor vehicles	Respiratory symptoms (e.g., cough, chest pain, difficulty breathing), pulmonary and cardiovascular disease
Volatile organic compounds (VOCs)	Motor vehicles, industry	Eye and skin irritation, nausea, headaches, damage to the liver, kidneys, and central nervous system

66. Referring to Table 2.4, which of the following pollutants can cause cardiovascular disease?
- a. carbon monoxide
 - b. particulate matter
 - c. ground-level ozone
 - d. sulfur dioxide
67. Which is a main characteristic of the stratosphere?
- a. strong vertical mixing
 - b. permanent temperature inversion
 - c. where meteors burn up
 - d. where all the weather occurs

chapter 2



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68. According to the figure, chlorine atoms change ozone molecules to what?
- oxygen molecules and oxygen atoms
 - CFC molecules
 - more ozone molecules
 - chlorine atoms
69. The temperature at the top of the troposphere is about _____ degrees Celsius.
- 0
 - 20
 - 40
 - 60
70. Which is photochemical smog?
- sulfur dioxide
 - ground-level ozone
 - nitrogen dioxide
 - VOCs
71. The main source of particulate matter in the United States is _____.
- coal burning
 - industrial processes
 - transportation
 - windblown dust
72. Which is a CFC source?
- human activity

chapter 2

- b. condensation
- c. ultraviolet radiation
- d. soil bacteria

73. The division between the troposphere and the stratosphere is called the _____.

- a. tropopause
- b. stratopause
- c. mesopause
- d. thermopause

74. The ozonosphere is anticipated to return to 1980 levels by about the year _____.

- a. 2020
- b. 2040
- c. 2060
- d. 2080

75. Which is an anthropogenic source of carbon dioxide?

- a. photosynthesis
- b. volcanoes
- c. fossil fuels
- d. anaerobic bacteria

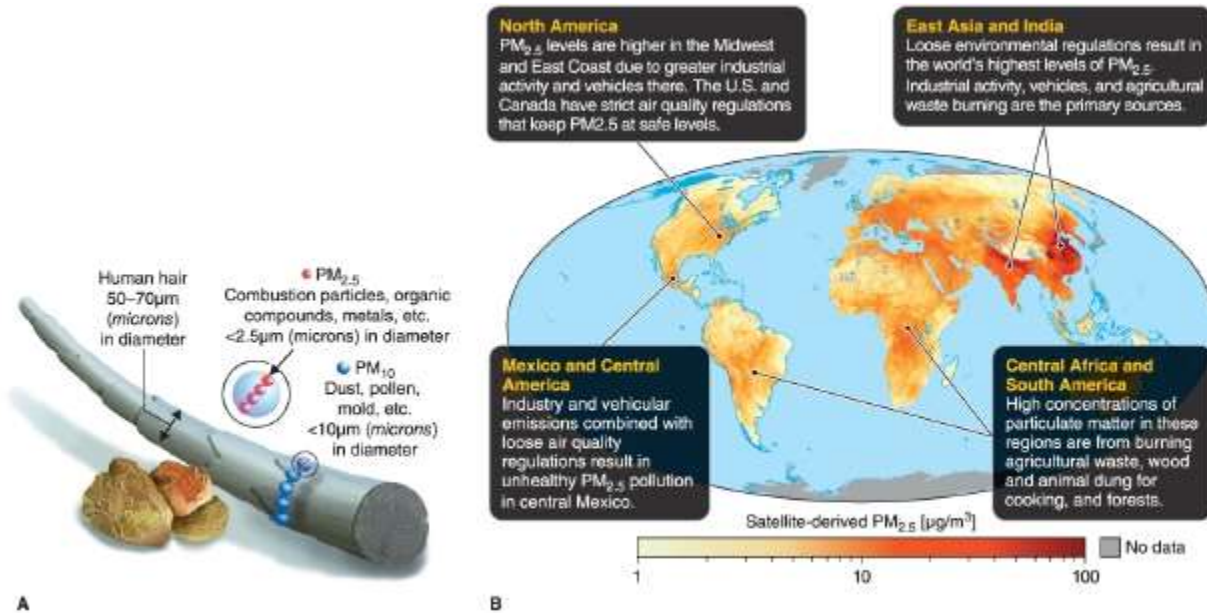
76. Which is a nitrous oxide sink?

- a. photosynthesis
- b. condensation
- c. ultraviolet radiation
- d. soil bacteria

77. The lowest-most layer of the atmosphere is called the _____.

- a. mesosphere
- b. stratosphere
- c. thermosphere
- d. troposphere

chapter 2



A. U.S. Environmental Protection Agency; B. Data from van Donkelaar et al. / NASA Earth Observatory

78. Referring to the map, what causes particulate matter to be high in northern India?

- a. dust storms
- b. industrial emissions
- c. agricultural emissions
- d. photochemical reactions

79. The Karman line defines what?

- a. the line where temperature in the upper atmosphere begins rising with altitude
- b. the half-way point between Earth's surface and the top of the atmosphere
- c. the "top" of the atmosphere
- d. the "top" of the troposphere

80. Which is not a greenhouse gas?

- a. water vapor
- b. oxygen
- c. methane
- d. ozone

81. Where are stratospheric ozone concentrations lowest?

- a. over the tropics
- b. over the midlatitudes
- c. over the North Pole
- d. over the South Pole

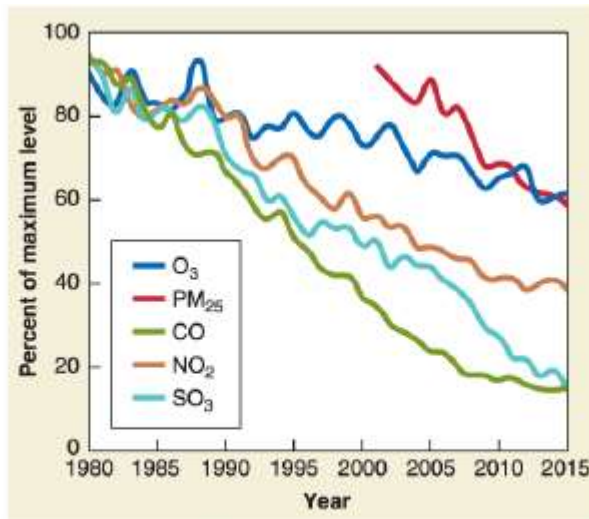
82. At sea level there are _____ pounds per square inch of air pressure on average.

chapter 2

- a. 10.8
 - b. 14.7
 - c. 15.4
 - d. 16.8
83. Which is a CFC sink?
- a. photosynthesis
 - b. condensation
 - c. ultraviolet radiation
 - d. soil bacteria
84. Which city has the lowest air pressure on average?
- a. Winnipeg, Canada—232 meters (761 feet)
 - b. Cairo, Egypt—23 meters (75 feet)
 - c. Ulan Bator, Mongolia—1,350 meters (4,429 feet)
 - d. Santiago, Chile—520 meters (1,706 feet)
85. Auroras are caused by _____.
- a. the solar wind
 - b. electromagnetic radiation from the Sun
 - c. high temperatures in the thermosphere
 - d. gas properties of the ionosphere
86. The top of the stratosphere occurs at about _____ kilometers.
- a. 40
 - b. 50
 - c. 60
 - d. 70
87. Which molecule depends on ultraviolet radiation to form?
- a. ozone
 - b. methane
 - c. carbon dioxide
 - d. CFCs and HFCs
88. Which molecule directly requires photosynthesis to be made?
- a. oxygen
 - b. carbon dioxide
 - c. methane
 - d. nitrogen

chapter 2

89. The top of the mesosphere occurs at about _____ kilometers.
- a. 80
 - b. 90
 - c. 100
 - d. 110
90. A problem with HFCs is that they _____.
- a. are toxic pollutants
 - b. cause ground-level ozone
 - c. affect plant photosynthesis
 - d. are strong greenhouse gases
91. The main source of anthropogenic carbon monoxide in urban areas is _____.
- a. automobiles
 - b. coal burning
 - c. burning agricultural wastes and forests
 - d. unburned gasoline

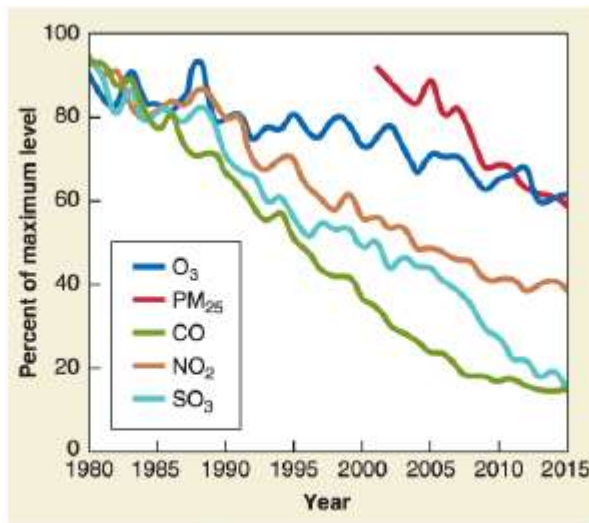


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92. According to the graph, which of the following air pollutant has dropped least?
- a. CO
 - b. NO_x
 - c. PM₂₅
 - d. SO₂
93. Which is a sink for carbon dioxide?

chapter 2

- a. photosynthesis
 - b. ultraviolet radiation
 - c. soil bacteria
 - d. volcanoes
94. What type of solar radiation causes ozone molecules to break apart and reform?
- a. visible sunlight
 - b. ultraviolet radiation
 - c. thermal radiation
 - d. microwave radiation
95. Which is a natural methane source?
- a. photosynthesis
 - b. volcanoes
 - c. fossil fuels
 - d. anaerobic bacteria



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96. Referring to the graph, what is responsible for the downward trend in these pollutants?
- a. population decrease
 - b. people driving fewer miles
 - c. enactment of the U.S. Clean Air Act
 - d. different measurement techniques
97. Which is a water-vapor source?
- a. evaporation
 - b. condensation

chapter 2

- c. ultraviolet radiation
- d. rainfall

98. The atmospheric lifetime of a CFC molecule can be _____ years or more.

- a. 10
- b. 100
- c. 1,000
- d. 10,000

99. Which city has the highest air pressure on average?

- a. Winnipeg, Canada—232 meters (761 feet)
- b. Cairo, Egypt—23 meters (75 feet)
- c. Ulan Bator, Mongolia—1,350 meters (4,429 feet)
- d. Santiago, Chile—520 meters (1,706 feet)

100. Which condition is not among the human health problems caused by exposure to increased levels of ultraviolet radiation?

- a. skin cancer
- b. respiratory problems
- c. reduced immunity
- d. cataracts

101. Which is a nitrous oxide source?

- a. photosynthesis
- b. condensation
- c. ultraviolet radiation
- d. soil bacteria

102. Clouds in the troposphere end at the tropopause because _____.

- a. the stratosphere is too warm
- b. there is too little water vapor in the stratosphere
- c. the stratosphere is too high for clouds to reach
- d. the stratosphere is too cold

103. When there is _____ it gets warmer as altitude increases.

- a. strong wind
- b. a temperature inversion
- c. an environmental lapse rate
- d. acid rain

104. An Air Quality Index (AQI) value of 100 indicates air quality that is in the _____ category.

- a. Good

chapter 2

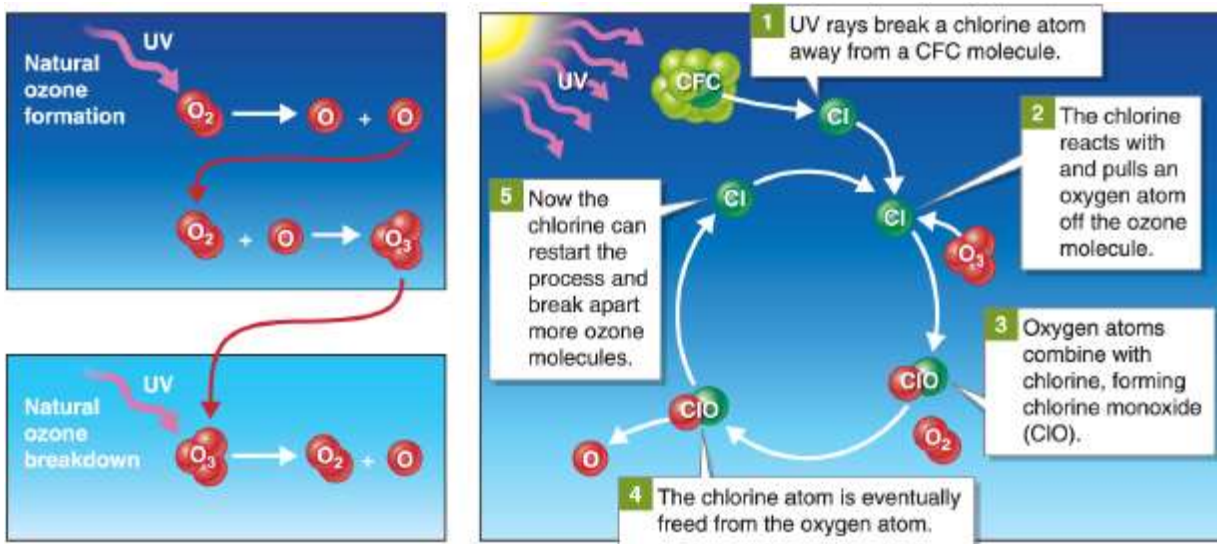
- b. Moderate
- c. Unhealthy for sensitive groups
- d. Unhealthy

105. The atmosphere is thicker in the tropics than at higher latitudes mostly because of _____.

- a. air circulation patterns
- b. gravity from the Moon
- c. Earth's rotation
- d. cloudiness

106. The geographically most extensive hole in the ozone layer occurred in what year?

- a. 1980
- b. 1990
- c. 2000
- d. 2010



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107. According to the figure, how is ozone broken down naturally?

- a. by reactions with CFCs
- b. by reactions with chlorine atoms
- c. by reactions with ultraviolet radiation
- d. by reactions with carbon dioxide

108. The division between the mesosphere and the thermosphere is called the _____.

- a. tropopause
- b. stratopause

chapter 2

- c. mesopause
- d. thermopause

109. When was the Montreal Protocol ratified?

- a. 1987
- b. 1990
- c. 1995
- d. 2001

110. What is the altitude of the Karman line in kilometers?

- a. 1
- b. 10
- c. 100
- d. 1,000

111. The tropopause is the division between what?

- a. the stratosphere and the mesosphere
- b. the troposphere and the mesosphere
- c. the troposphere and the stratosphere
- d. the stratosphere and the thermosphere

112. The top of the thermosphere is found at _____ kilometers.

- a. 400
- b. 500
- c. 600
- d. 700

113. Ninety-nine percent of the atmosphere is found below _____ kilometers.

- a. 32
- b. 100
- c. 170
- d. 200

114. The division between the stratosphere and the mesosphere is called the _____.

- a. tropopause
- b. stratopause
- c. mesopause
- d. thermopause

115. Which of the states of matter are clouds composed mostly of?

- a. water vapor

chapter 2

- b. liquid water
- c. solid water
- d. water gas

116. Which is an ozone source?

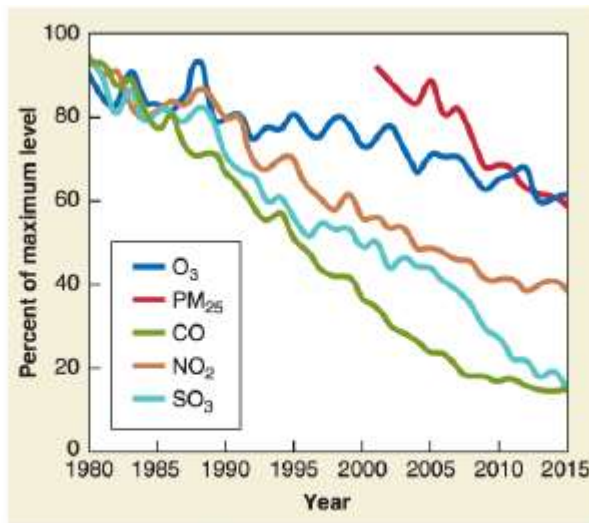
- a. photosynthesis
- b. evaporation
- c. ultraviolet radiation
- d. aerosols

117. Which is not found in the troposphere?

- a. a permanent temperature inversion
- b. all of Earth's weather
- c. the highest atmospheric density
- d. vertical mixing

118. The main source of particulate matter in northern Africa is _____.

- a. coal burning
- b. industrial processes
- c. transportation
- d. windblown dust



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119. According to the graph, which air pollutant has dropped most between 1980 and 2015?

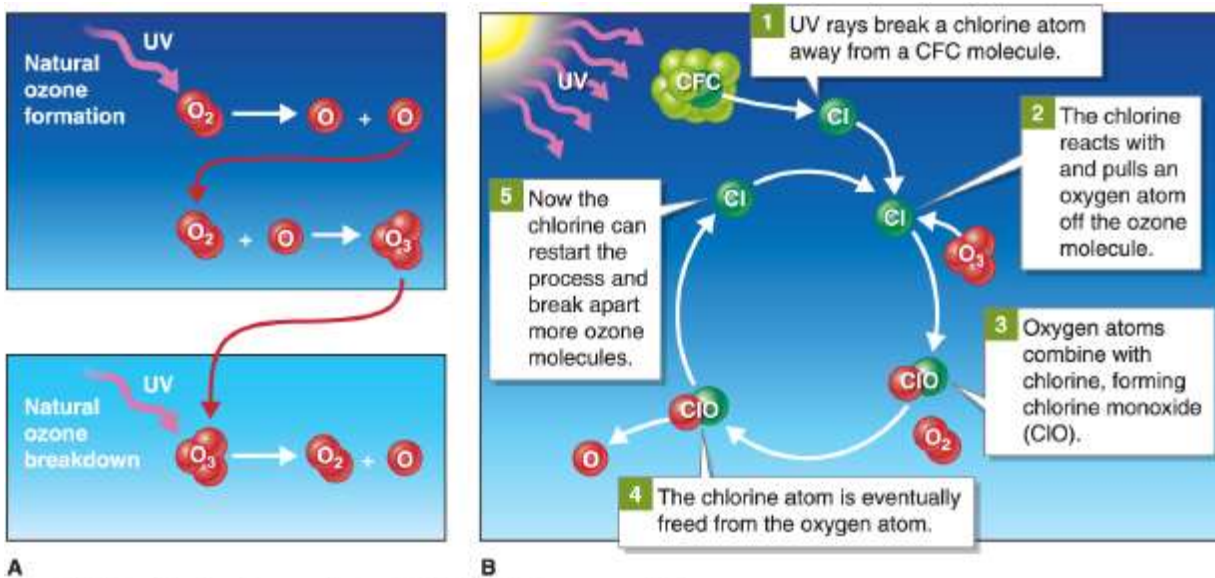
- a. CO
- b. NO_x

chapter 2

- c. PM₂₅
- d. SO₂

120. The temperature at the top of the stratosphere is about _____ degrees Celsius.

- a. 0
- b. -10
- c. -20
- d. -30



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121. According to the figure, how is ozone formed naturally?

- a. by reactions with CFCs
- b. by reactions with chlorine atoms
- c. by reactions with ultraviolet radiation
- d. by reactions with carbon dioxide

122. The timing of the solar wind coincides with the timing of _____.

- a. drought cycles
- b. solar flare activity
- c. stages of the Moon
- d. Earth's magnetic field strength

123. On average, the top of the troposphere occurs at about _____ kilometers.

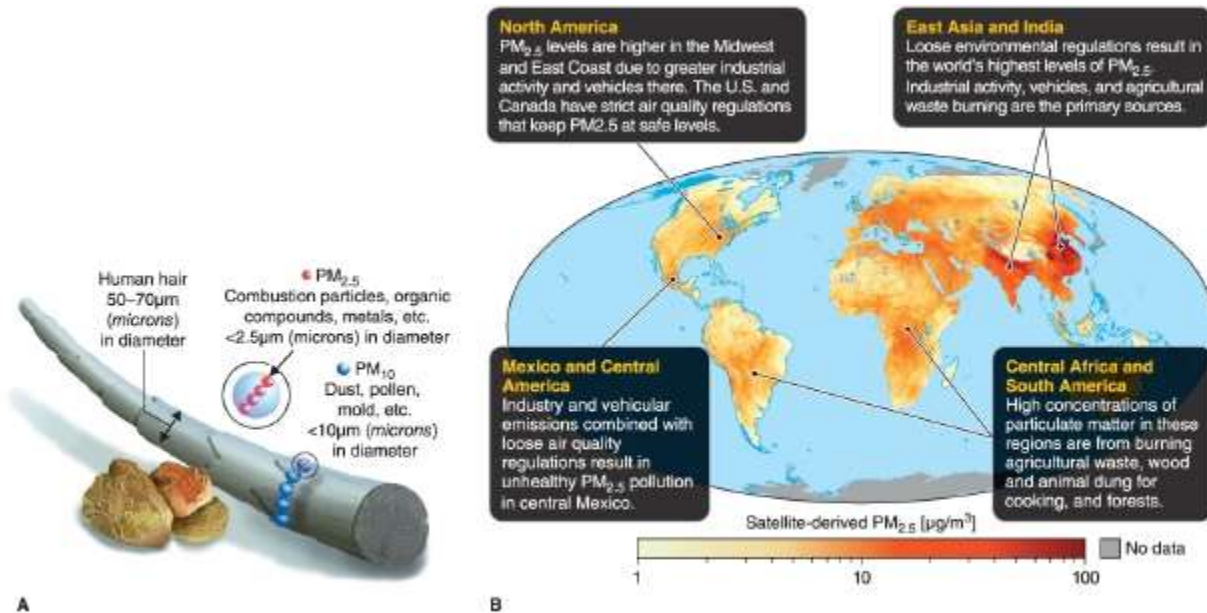
- a. 5
- b. 9
- c. 12

chapter 2

d. 18

124. The main source of nitrogen dioxide pollution is _____.

- a. burning of vegetation
- b. burning of coal and gasoline
- c. incomplete burning of gasoline
- d. chemical reactions in sunlight



A. U.S. Environmental Protection Agency; B. Data from van Donkelaar et al. / NASA Earth Observatory

125. Referring to the map, what causes particulate matter to be high in the eastern United States?

- a. dust storms
- b. industrial emissions
- c. agricultural emissions
- d. photochemical reactions

126. Given the geographic pattern of ozonosphere thinning, which location would have the highest UV radiation levels at ground level?

- a. the southern United States
- b. northern Canada
- c. northern Australia
- d. southern Australia

127. How are cumulonimbus clouds prevented from entering the stratosphere?

128. Why do CFC molecules persist in the troposphere, then break down in the stratosphere?

chapter 2

129. Cleaning up the air by reducing emissions is expensive. Industry ultimately passes the costs on to the consumer. Do you think the Clean Air Act is worth the expense? Explain.

130. The atmosphere and the oceans are heavy because they are composed of molecules that have mass and weight. Why, then, don't the atmosphere and oceans pin us down against the surface of Earth?

131. Why do cumulonimbus clouds in the troposphere not enter the stratosphere?

132. Describe how acid rain forms. Is acid rain decreasing or increasing in the United States? Explain why this trend has occurred.

133. What would happen to sea-level air pressure if the atmosphere were thinner? What would happen to sea-level pressure if the atmosphere were thicker?

Name: _____ Class: _____ Date: _____

chapter 2

Answer Key

1. True
2. True
3. True
4. True
5. False
6. False
7. True
8. False
9. True
10. False
11. False
12. True
13. True
14. False
15. True
16. True
17. False
18. False
19. False
20. True
21. True
22. False
23. True
24. False

Name: _____ Class: _____ Date: _____

chapter 2

25. True

26. True

27. True

28. True

29. True

30. False

31. False

32. True

33. True

34. True

35. True

36. True

37. d

38. c

39. b

40. c

41. c

42. a

43. b

44. c

45. c

46. b

47. a

48. a

Name: _____ Class: _____ Date: _____

chapter 2

49. b

50. c

51. c

52. b

53. b

54. b

55. a

56. b

57. d

58. d

59. b

60. a

61. b

62. d

63. b

64. a

65. d

66. b

67. b

68. a

69. d

70. b

71. a

72. a

73. a

Name: _____ Class: _____ Date: _____

chapter 2

74. b

75. c

76. c

77. d

78. b

79. c

80. b

81. d

82. b

83. c

84. c

85. a

86. b

87. a

88. a

89. a

90. d

91. a

92. c

93. a

94. b

95. d

96. c

97. a

Name: _____ Class: _____ Date: _____

chapter 2

98. c

99. b

100. b

101. d

102. a

103. b

104. b

105. c

106. c

107. c

108. c

109. a

110. c

111. c

112. c

113. a

114. b

115. b

116. c

117. a

118. d

119. a

120. a

121. c

122. b

chapter 2

123. c

124. b

125. b

126. d

127. The stratosphere warms with height. Cumulonimbus clouds become relatively cold, dense, and heavy in the stratosphere and so they cannot rise very far into it.

128. CFCs break down when exposed to UV radiation. In the troposphere there is relatively little UV radiation compared to the stratosphere.

129. Answers will vary. On a short-term basis, the two sides basically are pro economy vs. pro environment. Cleaning the air costs money and jobs. But cleaning the air improves the quality of life for people because they are healthier. On a long-term basis, it is much harder to argue for not cleaning up the air. In the long term, it saves money, helps the economy, and improves the quality of life for people.

130. Only a solid heavy object can pin us down because all of its weight will come from one direction only—from above us. The atmosphere and oceans are fluids, however, and they flow around us. Therefore their weight comes from all directions simultaneously and we are not pinned.

131. The stratosphere has a permanent temperature inversion. Cumulonimbus clouds rise higher in the troposphere as long as their interiors are warmer than the air outside of them. In the troposphere, it gets colder with altitude so as clouds rise they rise into colder air, keeping them relatively warm and buoyant. The permanent temperature inversion in the stratosphere causes clouds to become colder than the surrounding warm air. As a result, clouds cannot rise very far into the stratosphere.

132. Acid rain forms when sulfur dioxide combines with rainwater to form sulfuric acid droplets. Acid rain has been decreasing in the United States because of emissions restrictions mandated by the Clean Air Act.

133. Air pressure would drop if the atmosphere were thinner because there would be less atmosphere to compress. Air pressure would increase if the atmosphere were thicker because the weight of the overlying atmosphere would compress the atmosphere more.